

A Dividing Head

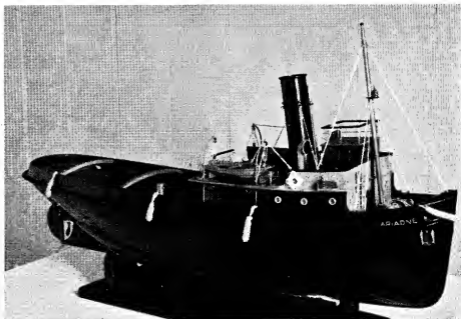
THE MODEL ENGINEER

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In this issue

SMOKE RINGS	265
IDEAS FOR THE EXILE ..	266
GAUGE "1" AS THE "HAPPY MEDIUM" ..	268
AMERICAN - TYPE UNIONS	271
A CHICAGO PICNIC AND MODEL EXHIBITION ..	272
"1831," A 3½-in. GAUGE I.C. ENGINE-DRIVEN LOCO- MOTIVE	273

A DIVIDING HEAD ..	277
SMALL CAPSTAN LATHE TOOLS	281
NUMBERING DRILLS DUR- ABLY	285
SETTING - OUT A TWO- THROW CRANKSHAFT ..	286
LETTERS	287
CLUBS	288



There are many keen model engineers who refuse to be daunted by the difficulties which war brings to the everyday life of most of us. This photograph shows a fine model tug built by Mr. G. A. Gauld out of "practically nothing"; turn to page 266 and read how it was done.

THE MODEL ENGINEER

Vol. 87 No. 2158

Percival Marshall & Co., Limited
Cordwallis, Works, Maidenhead

September 17th, 1942

Smoke Rings

Mined and Bombed, but a Loco. Lives

WE all know the saying which attributes nine lives to the domestic cat, but how many lives can we reasonably apportion to a model locomotive in the naval war zone? Here is the story of a model which has twice escaped extermination at sea and is now well on the way to successful completion. It has been told to me by Mr. R. Wallace-Sims, a Chief Engine Room Artificer, who has been through some thrilling experiences in the Mediterranean. He writes:—"I was interested to read in 'ours' of a locomotive built in a merchant ship and wondered how many models had suffered the experiences of a gauge 'O' 'Bat' which I am building. It started life in May, 1940, and towards the end of the year was almost complete, when the destroyer in which I was serving was mined and sunk. I salvaged the chassis, by carrying it in my overall pocket, but cab, running boards, boiler and tender are now the property of Davy Jones. A few weeks later I joined another ship and set about making another boiler, and refitting and cleaning the works, which had suffered through immersion in salt water. The boiler was almost complete when along came the battle of Crete, and a bomb fell close to the workshop in which the engine was kept, the net result being, once again no boiler and a bent and twisted chassis. Upon examination I discovered that the cylinders and wheels were intact, so once more a start was made. A few days ago a trial was made on air, and after a slight adjustment to the valve gear the engine spun round merrily on a half pound pressure, and when the pressure was raised to fifteen pounds the motion gear could not be seen. Although the locomotive started as a 'Bat,' she now has a 'Schools' cab and tender (I'm an ex-Eastleigh apprentice), but in all essentials she is still 'L.B.S.C.'s' design, and I hope when the boiler is complete that she will do all he claims. Now to build that boiler and to hope the third time will be lucky; anyway the workmanship should be good, as it is said 'practice makes perfect.' Before closing may I say how much I look forward to the

'M.E.', very few copies of which have failed to reach me." I congratulate Mr. Wallace-Sims on his personal safety, and hope he and his model will be spared any further misfortunes of the kind related. Good luck to them both.

A Model Hobbing Machine

A CORRESPONDENT kindly sends me a cutting from the *American Machinist* describing a miniature gear-hobbing machine made by a Mr. W. W. Dickover. The machine has 642 parts, and took the maker 2,640 hours to construct and assemble. It is driven by a 1/32 h.p. motor, and has a complete set of index speed and feed change gears. The castings for the machine are made in aluminium, with stainless-steel parts inserted for the wearing surfaces. The machine is one-sixth actual size, and will cut fine pitch gears up to 2 in. diameter. The description says: "Perhaps the most difficult job of all was machining the feed and index gear sleeves, which are 1/4 in. in diameter and have 3/16-in. bores with a solid integral key on the outside. The key was shaped in a lathe by moving the tool carriage back and forth, while turning the work around by hand in the machine."

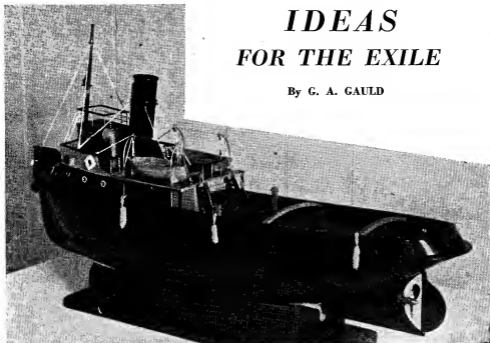
A Paper Salvage Hint

THE need for the salvage of every scrap of waste paper is as urgent as ever. Mr. F. Keedy makes the practical suggestion that readers who, like himself, have a number of volumes of THE MODEL ENGINEER in loose copies awaiting binding, can strip these copies of the covers and advertisement pages and preserve the editorial pages for future use. The material so retrieved would make a substantial parcel for the local salvage effort, and presents the additional advantage of saving an appreciable amount in the storage room required for the editorial pages. As Mr. Keedy says—"The good old weekly is still there for reference."

Percival Marshall

IDEAS FOR THE EXILE

By G. A. GAULD



A neat model steam tug made from odds and ends of material and with simple tools, while far from "home" and workshop

THERE must be many readers of this magazine who, like myself, switched to another part of the country, far from "home," have been forced to leave behind the workshop which provided many happy hours of relaxation in the "good old days" before the war started. It was no use grumbling. The lathe and I were parted for the duration. It was evident that if I were to continue to enjoy the pastime of model making, I must revert to my activities in pre-lathe days and tackle a job within the scope of ordinary hand tools. From that point of view, there is nothing to beat model boats.

Making a Start

Luckily, I had packed a few essential carpenters' tools, together with such items as a hacksaw, breast drill, a few files, small taps and dies and so forth, so that I was far from being unprovided. To get my hand in, I first set about the construction of a simple sailing yacht for my small son's birthday. There is nothing much to be said about that. Most of the materials used were scrap from the timberman's yard, and the spokeshave was applied until the hull lines appeared sweet to the eye.

The yacht finished, I cast around for something more ambitious, with

the result shown in the accompanying photographs.

It is not easy at the present time to get suitable timber. In this case, I had to be content with a pitch-pine log for the hull. It had a number of "shakes" and these became larger and more numerous as the work proceeded and the timber dried out. However, the cracks were filled with a mixture of glue and fine wood dust, the product of sandpapering. Not only does this mixture seal the cracks but it may be sandpapered when set so that no trace is apparent on the finished work, particularly after paint is applied. The hull was completed with the aid of a spokeshave, a chisel, a gouge and a borrowed auger, so the construction did not strain the resources of the tool chest.

Useful Plywood

A visit to the grocer produced a tea chest. The plywood from this was used in the bulwarks and upper works generally, and the decks. Deck houses were made from cigar-box wood, varnished. A length of brass tube, some thick copper wire, filed flat to a semicircular section for beading, and a soldering iron, produced the funnel. Practically all the deck fittings are of wood, aluminium paint being used on the bright

"metal" parts, including the anchor winch. A few commercial fittings were purchased, but the number was kept to the absolute minimum.

The lifeboats were clinker-built in the orthodox manner, upside down on moulds. The keel and planks are cut out of cardboard, Seccotine being used as an adhesive. Two good coats of paint have so far stopped the adhesive from breaking down due to damp, but it would probably have been wiser to have used a celluloid cement such as "Durofix."

An old gramophone motor was adapted to supply the motive power. This was not altogether easy in view of the impossibility of machining any parts, but a reasonably successful result was ultimately obtained. The boat travels at a reasonable speed, and has a duration of run of about fifteen minutes at one winding.

Very Satisfying

There is something very satisfying about a model steam tug. Possibly because of the relatively large scale which may be used, all the details, of which there are not too many, may be included, even in a working model. Consequently, a high degree of

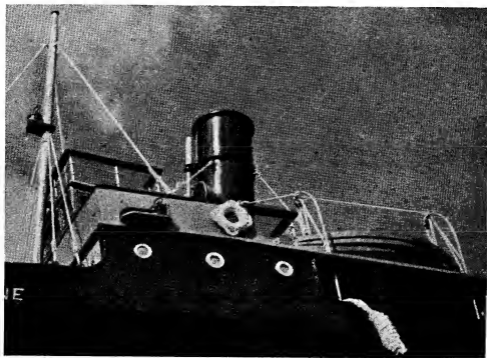
realism is obtained and the model looks well in the water. The job took nearly twelve months in somewhat limited spare time, but its construction provided a great deal of interest, particularly as much of the material used was "scrap."

Now, a Galleon

An Elizabethan galleon now occupies the stocks and the hull is well under way. Perhaps, when my struggles with the rigging are completed, a photograph of the model may grace these pages. Again, scrap materials are being used and I intend to make *everything* myself.

Drawings and Photographs

The ship is the *Elizabeth Jonas*, of the year 1600, and it is said that the original shipwright's drawings are the only ones of the period to have been preserved to the present time. Special prints made from the original drawings, and a comprehensive range of photographs of a large scale model from which the rigging may be built up, are available from:—The Secretary to the Board of Education, The Science Museum, South Kensington, London, S.W.7.



A realistic view of Mr. Gauld's model steam tug, taken from the "model" dock side.

Gauge "1" as the "Happy Medium"

By "L.B.S.C."

THIS week, let us have another little lobby chat on two or three points raised in recent correspondence, where same may prove of general interest; and for a kick-off a follower of these notes has asked for some information about a boiler for a proposed gauge "1" edition of Jimmy Holden's first oil burner *Petrolea*, which made its appearance somewhere around 1894. Although gauge "1" enthusiasts are in the minority, still it is a quite respectable minority for all that, and we must not leave them "out in the cold." Gauge "1" provides the happy medium between gauge "O," which is far too fiddling for your humble servant's liking, and $2\frac{1}{2}$ -in. gauge, which requires curves of larger radius than can be squeezed into the space available for trackage. Most gauge "1" "fans" are devotees of the "scenic" road, and don't care the proverbial "tinker's cuss" for passenger hauling; all they want is a locomotive which "looks real," is able to haul a "scale" train of a dozen coaches or thirty wagons or so, and—what is most important—keep on doing it. Many of them also have a decided leaning towards the locomotives of our childhood days of over fifty years ago, which for their size and power often did marvellous jobs of work; and with these I have a sincere bond of sympathy.

Boiler in the Tender?

The reader in question got out a drawing of his proposed engine, and was perturbed about the boiler. *Petrolea* was a standard 2-4-0 of the Great Eastern Railway, a neat-looking lassie in a shining blue costume. She had 18-in. by 24-in. inside cylinders with the valves underneath; 7-ft. coupled wheels, and a boiler with a short barrel only 4 ft. 3 in. diameter. Our friend scaled down a pair of "Molly" cylinders to half size, and found they would do very well, using loose eccentric valve gear; but allowing for lagging, which brought the diameter of the full-sized engine's boiler up to approximately 4 ft. 6 in., the diameter of the barrel on the small edition came out at only 1 11/16 in., and he wonders if this is going to be large enough. He calls attention to the scheming and "wangling" by both designer and builder of Mr. V. B. Harrison's gauge "1" Great Western single-wheeler in their desperate efforts to squeeze another $\frac{1}{4}$ in. on to the barrel diameter, and says that

when looking over some very old copies of the "Locomotive Magazine," he came across a description of a small engine with the boiler in the tender. Could a similar scheme be applied to his proposed engine, thus ensuring "scale" appearance with ample boiler capacity?

Marine Practice

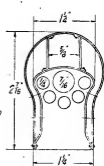
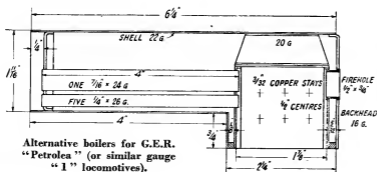
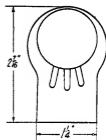
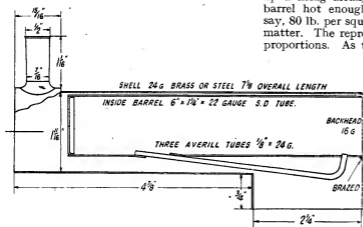
As a matter of fact, I recall that particular job quite well; and if memory serves me rightly, she was built by a Mr. E. Siddall. She was a 4-4-0 with a pair of double-acting oscillating cylinders located in the firebox of the dummy boiler, driving the crank axle like the engines of a paddle steamer. The boiler in the tender was also reminiscent of marine practice, being semi-circular in shape, something like a saddle tank, with an arch-shaped bottom plate having cross tubes in it, this plate forming sides and crown of the firebox. It was fired by a spirit lamp, the products of combustion passing up a flue at the back and going out at what would be the filling hole. A jointed pipe went from the boiler to the steam distribution blocks of the oscillating cylinders; and to the best of my recollection a plug cock on this pipe served as a regulator and was operated by the pseudo brake handle on the tender. The engine was reversed by a four-way cock connected to the usual reversing lever in the cab. The engine naturally ran very "wet"; and to prevent condensate water being thrown about when the engine was run indoors, a gadget like the silencer of an internal-combustion engine was fitted on the exhaust pipe between cylinders and chimney. The whole outfit was an ingenious dodge to overcome the boiler difficulties of those days; and, as far as I know, the engine ran very well, all things considered, though its power was very limited. Our friend referred to above was rather tickled with the idea, and thought that a more modern type of boiler in the tender of his proposed engine would be better than relying on a tiny generator in the usual position. Well, there is no need for it at all. We have learned a dickens of a lot about boilers and steam generation since those days—at least, those of us who are actual builders and "experimentalists" have; the other kind are still where they have always been and always will be!

Suitable Small Boilers—the Water-tube Type

In all my boiler experimenting—and I have done probably more in that line than anybody reading these notes, and certainly built more than others who write about them, as I passed the three-figure mark years ago—there is one outstanding fact to which I have called attention before, and for new readers' and novices' benefit will repeat; it is not the *size* of the boiler which governs the rate of steam generation, but the *temperature* at which you can maintain it. People refused to believe me when I stated that I had made a success of a water-tube boilded locomotive which originally had been a failure, by putting a *smaller* boiler on it, but it was an absolute fact. The reason was simply this; the original boiler, made very definitely outsize in a frantic attempt on the part of the builder to ensure an adequate steam supply, defeated its own ends by carrying a bulk of water that was too large for the heating apparatus to maintain at the required temperature. I demonstrated this to him by emptying nearly all the water out of it after unsuccessfully trying to maintain working pressure with a "full pot"; and

with only a couple of tablespoonfuls in the bottom, pressure began to *rise* instead of fall. Many owners of water-tube boilded engines with no pumps have noticed that, just before the boiler runs dry, there is usually a terrific spurt and some blowing off, provided the engine part is O.K. and does not waste the steam. On the engine referred to above, the heating arrangements were not altered in any way, but a new and much smaller boiler replaced the outsize "kettle." Not only was there less water, but much less metal in both inside barrel and outer casing; and, in addition, the new casing was lined with asbestos millboard. The net result was that with the same amount of heat applied, the new smaller barrel was kept at a far higher temperature than the original one, and the needle of the steam-gauge kept well around to the place where it belonged.

Such being the case, all we have to do in order to provide a suitable water-tube boiler for the little *Petrolea* is to take the "scale" size of the big engine's boiler and firebox wrapper and make the outer casing of the little one to correspond; we can then arrange a suitable barrel inside it, and fix up a firing arrangement to keep the said barrel hot enough to maintain steam at, say, 80 lb. per square inch, which is an easy matter. The reproduced sketches show the proportions. As to construction, even if a



Alternative boilers for G.E.R.
"Petrolea" (or similar gauge
"1" locomotives).

piece of tube 1 11/16 in. outside diameter were available, and split and opened out to form the firebox, the latter would not be deep enough, and an extension would have to be riveted or brazed on in any case; so the best thing to do is to roll up the barrel (not roll it out; wait until you've finished for that!) and wrapper from a piece of 24-gauge brass or steel sheet. The longitudinal seam can be lapped and riveted, as it does not hold water, and the throatplate can also be riveted in, being flanged over at both sides for the purpose.

The backhead is knocked up from 16-gauge sheet-copper over an iron former in exactly the same way as I have described for bigger engines with regular loco.-type boilers. The inside barrel is a 6-in. length of 1 1/2-in. gauge seamless copper tube, squared off at both ends in the lathe, set on the backhead as close to the flange at the top as possible, and brazed. The front end is closed by a flanged disc of 18- or 20-gauge copper, the flange being turned like a smokebox tubeplate and driven into the end of the barrel, then either brazed or silver-soldered. Three water tubes, of 1/2-in. by 24-gauge seamless copper, are put into the bottom of the barrel by the method devised by the late Mr. T. W. Averill, and silver-soldered in place, as shown in the illustration. The fittings can be smaller editions of those I have described in full for 2 1/2-in. gauge engines. For this type of boiler I strongly recommend the cam-operated pin regulator, which gives a positive shut-off every time, and requires no lubrication whatever.

Firing Arrangements and Smokebox

Although big sister *Petrolea* burned oil, hence her name, she had a regular locomotive-type boiler. There were two short tubes about 6 in. diameter at footplate level, below the firehole door, and the nozzles of the two steam-operated spray burners poked through them, the firebars being covered with a layer of broken firebricks and lumps of chalk, with a few shovelfuls of coal added to maintain "life" when the burners were shut right down whilst the engine was standing. The little engine will also do very well indeed on oil, but the thick black soothing-syrup which her big relation thrived on would prove a wee bit too heavy for her delicate constitution (not to mention the effluvium when working indoors!), so she can be fed on paraffin or—dare we whisper it?—petrol. A vaporising burner such as I described for the gauge "1" Southern "V" class ("Schools") engine "St. Hilda" would be just the ticket, and will operate on either fuel merely by varying the size of the nipple, paraffin

needing a smaller one than petrol. The latter starts up quicker and is cleaner, but as regards delivery of "therms" there is no appreciable difference.

Spirit could also be used for firing, though this is more expensive, gives less heat, and the driver is advised always to carry his gas-mask. The only advantage is that it only needs wicks, six 1/2-in. wick tubes in two rows being sufficient to provide enough heat to maintain full pressure. Note that methylated spirit needs plenty of air to ensure complete combustion, and the blast nozzle should be arranged so that the draught is as fierce as is needed for a coal fire (the vaporising oil burner needs only a moderate blast), and that brings us to the smokebox end.

The "scale" length of the smokebox in gauge "1" is 15/16 in. and it is of larger diameter than the boiler barrel. This effect can be easily obtained by wrapping a strip of 16-gauge sheet metal around the front end of the barrel and taking the sides down between the frames, to which they are attached, so that no separate smokebox saddle is needed. As the size and shape of the chimney make or mar (usually the latter!) the appearance of a little locomotive, here is the exact size and shape of *Petrolea's* chimney for gauge "1." It is the regular Holden stovepipe, 1 1/16 in. high, 1/2 in. wide at top, tapering to 7/16 in. at the point where the flared base begins 5/32 in. above the smokebox. The flared piece opens out to a width of 13/16 in., saddled, of course, to fit the curve of the smokebox, and the joint between flared base and the chimney barrel is stepped to the extent of the thickness of the metal. The beading around the top is made by filing away half the diameter of a piece of 22-gauge wire and bending it into a ring which is silver-soldered on.

Locomotive-type Boiler

Maybe our friend, or somebody making a gauge "1" locomotive with a boiler of similar dimensions, would prefer the regulation loco.-type generator, so I have pleasure in giving a sketch of one suitable. The outside measurements are precisely the same as the water-tuber, except that the barrel is 1/2 in. shorter, the smokebox being separate in this case, for convenience in fitting the smokebox tubeplate and the superheater element. The material used should be 22-gauge sheet copper, and the joints of the longitudinal seam and throatplate must be brazed or silver-soldered. The inside firebox is made from 20-gauge copper, with 16-gauge tubeplate, the sides being splayed out at the bottom to meet the shell. This gives a bigger grate area, allowing more air to get

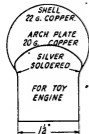
to the oil burner on a little *Petrolea*, or more firebar surface for coal burning on a similar-sized engine using solid fuel. The smokebox tubeplate is 16-gauge copper and is joined to the firebox by one 7/16-in. by 24-gauge superheater flue, and five 1/4-in. by 26-gauge firetubes, the lot being silver-soldered at both ends. The crown of the firebox is stayed by two plate girders as shown, and the sides by ordinary screwed staybolts made from 3/32-in. copper wire or copper rivets. Use 60-thread if tap and die are available; if not, 7 B.A. The backhead is the same as the water-tube boiler, but it is

specified for the top of a loco-type firebox, as the pressure would run up considerably over 30 lb.

The above remarks will be found useful to anybody building small-boilered gauge "1" engines of any type, as the general "rules" apply to any engine; but should anybody else be interested in the G.E. *Petrolea*, I have all details of her, and would be glad to furnish a sketch and particulars of the outline and "works" in these notes. She would make a lovely little job in either 2 1/2-in. or 3 1/2-in. gauge, especially the latter.

American Type Unions for Pipe Work

Mr. W. R. Cook, Mr. D. Nicholson, and one or two others call attention to the type of union used freely in the pipe work on American machine tools, automobiles, and in other branches of engineering, and suggest its use on little locomotive "plumbing" work. In this union the screwed part is formed with a male instead of a female end, and the pipe, instead of having a cone on it, is opened out to fit over the coned end of the screwed part, the nut clamping the pipe tightly to the cone. There is no objection at all to using this type of union in little locomotive work, in places where the unions are very seldom uncoupled after the engine is erected. As a matter of fact, I usually employ them on pressure gauge siphons, water gauge blowdowns, and so on. The advantage to the owner of a small lathe with single slide rest is that the exact angle of the cone is of no moment, and it can be formed by deeply chamfering the end of the



Section of boiler for a Gauge "1" "toy" engine.

Toy Boiler of Similar Size

Whilst we are on the job, as I frequently receive requests for a boiler which is the absolute rockbottom of simplicity, usually for a simple loco. made to please a kiddy, here is a sketch of the above boiler "modified" to suit. The shell is made up as for the loco. type, but 24-gauge brass or copper will be strong enough for pressures below 30 lb. An arch plate of 20-gauge copper is cut and bent to shape shown in section, and extends from the backhead to within 1/4 in. of the end of the barrel; a piece of 18-gauge sheet copper the shape of a crescent moon which has knocked its horns over against one of the planet's is fitted into the gap at the smokebox end and silver-soldered. The space between the underside of the arch plate and the bottom of the barrel forms the flue. This simple gadget will steam a single 7/16-in. bore cylinder or a couple of oscillating cylinders, and run quite a while without refilling. A spirit lamp with six small wicks as mentioned before, could be used for firing; or, if something simpler is required, two only, using wick tubes about 7/16 in. diameter could be fitted. The little kettle would make a lot more steam if fired by an oil burner; and in that event it would be advisable to stay the arch plate to the shell by a few direct wire stays, or a couple of light girders similar to those I



Simple American-type pipe union.

screwed section of the union before parting off. The union nut should be short, and the hole in it should be a nice sliding fit on the pipe. The end of the tube should be squared off truly, and then enlarged with a tool like a glorified centre punch to a shape which will fit over the coned end of the screwed part. When the nut is tightened up, it squeezes the soft copper into close contact and makes a tight joint. This type of union is not, however, suitable for positions where the union is frequently connected and disconnected, e.g. the hand pump line between engine and tender, as the pipe would soon be either cut through, or squeezed out too thin to hold properly.

A Chicago Picnic and Model Exhibition

WE are indebted to

Mr. A. Scott, of the Chicago Society of Model Engineers, for some notes and pictures of a picnic outing held by that society in June last.

Our American friends are fortunate in being able to hold an enjoyable outdoor fixture of this kind in these difficult times. In pre-war

days such meetings were beginning to achieve popularity in the home country, but naturally have had to be suspended in the changed conditions. The list of exhibits furnished by Mr. Scott is of interest partly as showing the trend of model-making in the Chicago Society, and partly because it indicates that much of the inspiration for their models is derived from this side of the Atlantic.



Two of the locomotives.

Mr. L. E. R. o y Brakke's $\frac{3}{4}$ -in. scale free-lance English locomotive and an 'L.B.S.C.' 'Fayette' Pacific. These two engines were running double header most of the day. Mr. L. Achor, who came from Flossmor, Ill., had his $\frac{3}{4}$ -in. scale Atlantic. Mr. Stenholm, of Rockford, Ill., had a

Pacific 4-6-2 with shuttle pump. A three-way switch-over was laid at one end of the track and this was used like a little round-house where coal and water were taken on.

Partly finished locomotives on display were by Mr. W. Peters, $\frac{3}{4}$ -in. scale "Hudson"; Mr. H. D. Collins, $\frac{3}{4}$ -in. scale "Montano" 4-8-4 with Timkin bearings on all drivers; Mr. E. C. Cox, $\frac{3}{4}$ -in. scale 4-6-4, built from Langworthy drawings. (This is a beautiful



Starting up!

The picnic was held at Rodians Grove on June 21st, 1942, 24 miles west of Chicago. Early arrivals had the job of laying 120 ft. of $\frac{3}{4}$ -in. scale track for the locomotives which gave rides to the children under the watchful care of the owners. Tables were also set up for the small models. Locomotives with steam up were run by the following members.

job, with every detail precision made and fully equipped with air brakes); Mr. R. L. Germaine, $\frac{3}{4}$ -in. scale 4-6 4 same as Mr. E. C. Cox. Mr. H. Scott and Mr. E. Ohlencamp each have a $\frac{3}{4}$ -in. scale "Rainhill" designed by "L.B.S.C." of England.

Mr. L. Fehrenwald brought a 1/50 scale

(Continued on page 276)



* EDGAR T. WESTBURY'S **1831**

Cutting the Transmission Worm Gearing

THE material for the worm wheel is bronze or tough gunmetal.

Pitch diameter : 1 5/16 in.

Number of teeth : 30.

Addendum : 0.050 in.

The blank is machined as described for the pinion, the same pains being taken to ensure concentricity of the bore and the outer surface. The bore should be made a fairly tight press fit on the jackshaft, which may be used as a mandrel for turning the outside of the blank, provided that it runs truly—which is essential in any case. A key is specified in the drawings to ensure a positive drive, and should be very carefully fitted so that it is neither so tight as to throw the wheel out of truth, nor slack enough to permit any play, which would eventually cause damage to both the shaft and the wheel. If properly fitted, it should not be necessary to provide any means of preventing the wheel moving endwise on the shaft, but a pin or grub screw may be fitted as a precaution against this eventuality, if desired.

As an alternative to keying the wheel, the bosses on either side may be made longer, and either taper or parallel pins driven

through both boss and shaft each side, one at right-angles to the plane of the other.

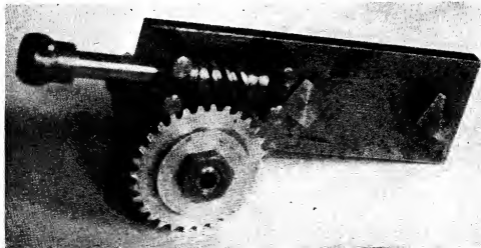
Fixture for Cutting the Worm Wheel

In order to generate the correct form of tooth for the worm wheel, the cutting of the teeth is carried out by mounting the blank on a vertical mandrel, which is rotated at a speed relative to the lathe mandrel corresponding to the relative speeds at which the worm wheel and pinion will eventually run. The cutter is rotated between the lathe centres, and the blank is fed into cut by the motion of the cross slide.

The fixture required to carry this out is a relatively simple one, consisting of a device to carry the vertical mandrel and gear for rotating it at the required speed. This is driven from the lathe mandrel, through the change wheels and a universally-jointed transmission shaft, the complete set-up being clearly seen in the photograph reproduced herewith.

It will be noted that the drawing of the fixture (Fig. 131) differs in detail from that in the photograph, the reason being that, although the latter served its purpose reasonably well, it has been found possible to add certain improvements to the design, mainly with the object of making it more

*Continued from page 236 "M.E.," September 3, 1942.



Underside of worm wheel generating fixture.

adaptable, not only to various lathes, but also to cutting worm wheels of widely varying diameter and pitch. These improvements have, therefore, been incorporated in the design.

The actual construction of the fixture may be modified to suit the material available for its construction, or according to the size of lathe to which it is adapted. It will be seen that the soleplate is made from a piece of flat stock material, as I happened to have some flat mild steel plate large enough to make it out of. This is perhaps a little on the light side, but has not given any cause for complaint on the score of rigidity. The use of a casting of appropriate shape, with a vertical boss to form the bearing or bush housing, would undoubtedly be best in this respect. I have, however, made the bush itself heavy enough to be fairly rigid, and have provided it with a flange and close-fitting spigot, screwed on the lower end, and clamped to the soleplate with a thin nut. As an alternative means of attachment, the flange might be made larger in diameter and secured to the soleplate by three or more screws. Its height is limited by the need for mounting the blank so that the centre of the tooth face is exactly level with the lathe centres—if necessary, insufficient height can be compensated by packing, either on the mandrel or under the soleplate, but nothing can be done about it if the shoulder of the mandrel is too high.

A Universal Device

In view of the corrected bore dimensions of the gear, the $\frac{3}{8}$ -in. diameter mandrel nose will not be large enough to fit the bore direct, but visualising the possibility that the fixture may be used later on for all sorts of gears, it will be advisable to make the dimension as shown, and fit a temporary bush to take up the clearance in the bore of the wheel. A better plan still, if one wishes to make the device really universal, would be to provide it with a hollow mandrel, having an internal cone, to take a draw-in spindle for collets or coned arbors. The mandrel is tapered externally at an angle of 60 degrees, below the collar, to provide a thrust surface of ample area, and also to enable any play which may develop to be eliminated. I have found it most essential to avoid any trace of end or side play in the mandrel, but at the same time undue friction must be avoided, or the power required to rotate it will be excessive, and an unfair load thus imposed on the driving gears and transmission shaft. End play is taken up by the nut on the mandrel above the worm gear, while the lower nut is used to clamp the latter firmly, and also to lock the adjustment. If this worm is keyed to

prevent it rotating on the spigot of the mandrel it will form a keep washer and thus prevent any tendency for the adjusting nut either to slacken or tighten.

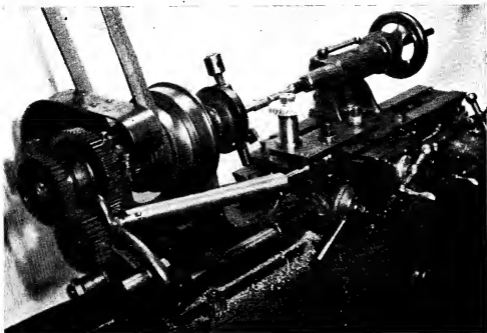
Regarding the securing of the blank, there is a tendency for the top nut to slacken off when cutting left-hand worm wheels, and thus a prudent provision would be to cut a keyway or flat on this end, and equip it with a keyed washer under the clamping nut. This is not necessary if the device is used exclusively to cut right-hand worm wheels. Obviously, the risk of the blank slackening off while gear cutting is in progress must at all costs be avoided.

Ratio of Worm Wheel and Worm

The worm wheel and worm used to drive the mandrel may be of any ratio so long as it is possible, with the aid of the available change wheels, to gear up so that the blank rotates at the correct rate relative to the cutter, which in this particular case is in the ratio of 7 to 30. If it is necessary to cut a special worm wheel for the job—as it was in my case—it may be made with a thin tooth face, so that it is only necessary to cut the teeth at approximately the correct angle by ordinary index milling. Generated teeth are unnecessary, as the transmission efficiency for this job is relatively unimportant, but as the worm wheel is a "master" gear, it should be indexed as accurately as possible. It is, however, more than likely that a worm and wheel suitable for the purpose can be obtained ready-made if one has access to a good junk yard.

The worm gear which I have used has a ratio of 5 to 1, and thus, when driven through change gears having a ratio of 7 to 6, it provides the required ratio of blank to cutter. This is obtained by using a 35 wheel on the lathe mandrel and a 30 wheel on the transmission spindle, i.e.: $35/30 \times 1/5 = 7/30$. It may be noted that the gears shown in the photo are not part of the regular set of change wheels supplied with the lathe; this was done because the use of the standard gears would have made it necessary to fit two intermediate idlers to enable the transmission shaft to clear the spur wheel of the back gear. As some odd gears of coarser pitch were available, they were used to avoid the extra friction and backlash of a four-wheel train. It would have been better still if wheels of 70 and 60 teeth, respectively, had been available, as the greater number of teeth reduces the individual tooth load, and tends to reduce angular errors.

In the fixture shown in the photo, the worm-shaft was fitted in two individual bearing blocks, each attached to the underside of the fixture by two screws, in slotted



Lathe set-up for cutting worm wheel, showing cutter bar and blank in position, also gearing and transmission shaft.

holes, which enabled a limited amount of mesh adjustment to be obtained. End-play of the worm was taken up by a thrust washer between the bearings. An improved arrangement is shown in the drawing, consisting of an inverted U-bracket, incorporating the wormshaft bearings, and attached under the soleplate by two studs. These pass through slotted holes in the soleplate, which provide for a much wider range of adjustment, with no risk of interfering with the alignment of the bearings. Lock nuts are provided on the wormshaft to take up end-play, but their thickness must be cut down to the minimum, as it increases the inevitable overhang of the fixture from the side of the cross slide. Both the end-play of the worm, and backlash in the meshing of the worm and wheel, must be eliminated as completely as possible.

The coupling on the wormshaft constitutes the simplest possible form of universal joint. It consists of a spherical boss or hub attached to the shaft, and having a cross pin which engages slots in the tubular ends of the transmission shaft. Both the fit of the pin in the slots and of the coupling in the bore of the tube should be neat enough to eliminate backlash, but binding, either general or local, must be avoided.

If desired, a more elaborate form of universal joint may be employed to couple both ends of the transmission shaft with the gear spindle and the worm wheel cutting fixture, but it is most important that it should be made accurately and run truly. A "Hooke's coupling" is one of the oldest and soundest forms of universal joint, but it needs to be very carefully made in order to work properly. Ready-made universal joints are often employed in the feed gear of machine tools; these are very accurately made, and if a pair of them should be available, they will suit the purpose quite nicely. But nearly all these devices are designed to work at a rigid shaft length, and unless some additional provision is made for "telescoping" the transmission shaft (this is nearly always done in machine tool feed gear) they prevent the fixture being moved endwise, which is desirable in the present case.

Change Wheel Spindle

This fitting is necessary to enable the drive obtained from the lathe mandrel, through the change wheels, to be transmitted to the fixture by way of the transmission shaft. It consists simply of a spindle with a seating to fit the bore of the change wheels, at one end, and a coupling

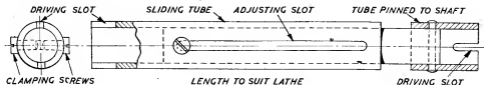


Fig. 133. Telescopic transmission shaft.

similar to that on the wormshaft of the fixture at the other (Fig. 132). The spindle runs in a sleeve bearing which can be clamped in the slot of the change wheel quadrant. As the width of this slot is only about $\frac{1}{8}$ in. in small lathes, the largest size of spindle which can be employed is about $\frac{5}{16}$ in., but this is ample to carry the torque normally required. The sleeve may be made about $\frac{1}{8}$ in. diameter, and flattened at the sides, as shown in the section, to pass through the slot; it is provided with a fine thread nut to clamp it in position. As the coupling will have to be removed to insert the spindle through the slot, the cross pin should not be fitted too tightly; but in order to avoid the possibility of it working out when in use, a grub screw may be fitted to engage a dimple or notch in its centre, if desired.

Transmission Shaft

It will be seen from the photographs that the member used to transmit the drive, in

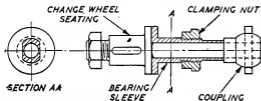


Fig. 132. Change wheel spindle for driving worm wheel generating gear.

the appliance used in my experiments, was simply a piece of tubing of a size to fit over the spherical couplings and having slots in it to take the cross pins. This served its purpose fairly well, but necessitated using the fixture at a constant position on the lathe bed, except for a slight latitude as provided by the length of the driving slots. In order to make the device more adaptable, and avoid the need of having to make the cutter spindle or hob mandrel to a fixed specification in respect of length, it is advisable to employ an extensible transmission shaft, such as that shown in Fig. 133. In this case, only the two end portions are made of tubing large enough to fit over the couplings; the centre portion may be either a solid shaft, or a smaller diameter tube. A short length of the larger tubing is

firmly pinned to one end of this to form one of the coupling sleeves; the other is much longer and provided with diametrically-opposed slots, which allow it to be adjusted for length on the shaft. The driving slots at the two ends of the shaft must be at right angles to each other.

It is not intended that the shaft shall be allowed to "telescope" while working, neither is it desirable for it to do so unless the form of joint employed renders such provision necessary, as specified above. The slotted sleeve is therefore clamped to the shaft, after it has been adjusted, by means of two screws. In the event of having to arrange for telescoping movement, keys may be substituted, but they must fit very neatly, so that they do not constitute another source of lost motion.

(To be continued)

A Chicago Picnic

(Continued from page 272)

Cape Henry Lighthouse, year 1791 to 1881. It is equipped with fog horn and a radio beacon 100 watt light, which works like the real old-timers. Mr. Fehrenwald also had a display of fine tools.

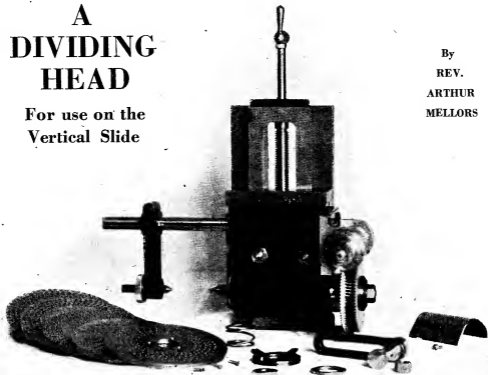
Mr. J. Matthews contributed a triple expansion engine with reversing gear, 2-cylinder high speed engine, 2-cylinder Stuart Turner engine, 2-cylinder Westinghouse racing engine, 1-cylinder flash steam racing engine. Also a fine model of the old-time "Rocket" locomotive. Mr. R. Brakke had a small traction engine and a 2-in. gauge steam locomotive under construction. Mr. A. Scott showed a 4-cylinder V-type steam engine. This model was made from drawings printed in one of the first issues of the *Model Craftsman* magazine. Also a 4-cylinder V-type steam engine with piston valves, which has a cross-head arrangement to drive the valves. Mr. W. Cordes brought out his public address speaker and furnished us with the latest music.

Three beautiful cups were awarded, the judges having a hard time to pick the winners. They were awarded to Mr. Achor for his $\frac{3}{4}$ -in. scale locomotive; Mr. J. Matthews for a triple expansion steam engine; and Mr. A. Scott for a fine 4-cylinder V-type steam engine.

A DIVIDING HEAD

For use on the
Vertical Slide

By
REV.
ARTHUR
MELLORS



Components of the dividing-head.

A FIRST-CLASS dividing head is one of the many refinements of equipment which can be made by the keen model engineer. Its construction calls for much skill and extreme accuracy, but once finished it will be both a thing of pride and a tool of increasing usefulness. With it, the circle can be accurately divided; regular and irregular shapes can be spaced, set out and machined; and if so designed it can be used for simple rotary table work.

The tool about to be described was designed for mounting upon the vertical slide; the work being held in a collet or chuck, or mounted upon a faceplate, or run between a pair of centres; whilst the cutter is mounted on an arbor between lathe centres; or (in the case of an end-mill) gripped in either lathe collet or self-centring chuck.

In full-sized machine shops dividing heads are now fairly standardised pieces of equipment. Basically they consist of reduction gears which are nearly always 40/1 ratio, and a division plate, or plates, by means of which the fraction 40/1 can be further divided. Both the Edgwick and the Cincinnati dividing heads are supplied with a plate known as the "standard plate"

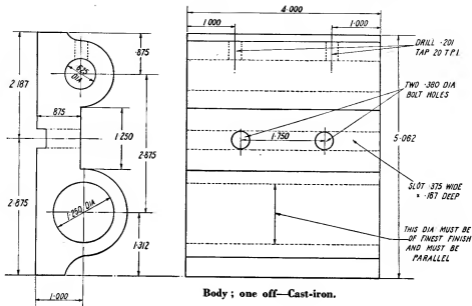
which has circles of 24, 25, 28, 30, 34, 37, 38, 39, 41, 42, 43, 46, 47, 49, 51, 53, 54, 57, 58, 59, 62, 66 holes. Other plates can be obtained if required. These are known as "high indexing" plates and contain circles of holes such as 77 and 127, etc.

To those who are unaccustomed to these facts all this may sound extremely complicated, but the use of the dividing head is actually a very simple process of arithmetic. Everything follows from the fact that forty turns of the operating handle are required to turn the spindle carrying the work once. If a division of 2 is required then it is obvious that 20 turns of the handle will be needed for each division. For eight divisions

the turns required will be $\frac{40}{8} = 5$; for 13

divisions the turns will be $\frac{40}{13} = 3 \frac{1}{13}$. Now

it is when dealing with the fraction $1/13$ that the circles of holes come in. A circle is provided, e.g. which has 39 holes; 13 divides into this three times. So it becomes plain that for 13 divisions we need the operating handle set to engage in the 39 circle; and 3 complete turns and 3 holes



will index our job correctly. Just one small pitfall is present for the unwary—*never count the hole in which the plunger starts as 1 hole.* 3 holes means 3 holes after the plunger.

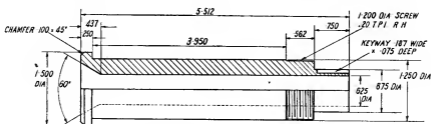
It was decided from the outset to make a head as nearly standard as possible; the only limiting factor considered was the necessity of compression into the capacity of a 4-in. lathe. Provision was made, therefore, for a series of interchangeable plates instead of the usual single large plate drilled upon both sides. Finally, five plates were decided upon and these are divided as follows:—

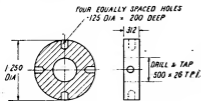
Plate 1.	24.	25.	28.	30.	34.
" 2.	37.	38.	39.	41.	42.
" 3.	43.	46.	47.	49.	
" 4.	51.	53.	54.	57.	
" 5.	58.	59.	62.	66.	

Reduction gearing is by means of a 2-start 4 t.p.i. steel worm engaging with a phosphor-bronze gear of 80 teeth. Thus the reduction is 40/1, and the completed tool will divide

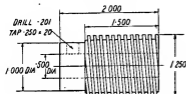
the circle into all numbers up to and including 60; all even numbers and those divisible by 5 up to 120; and a great many other divisions up to 400. If necessity arises at a later date it will be possible to extend the range by the addition of further plates containing the "high indexing" numbers.

Two castings are needed, and for these wooden patterns should be made. One is for the body and the other is for the bracket which carries the worm. Much consideration was given to the question of separating these two parts. "Why," it may be asked, "was not one casting devised which would incorporate the bracket?" The answer is simple. To calculate the centres required for the worm and its gear is easy; to mark this out is also easy. But to machine the casting, the worm and the gear so that all three will mate without backlash or binding is a task which is beyond the average modelmaker's equipment—and this dividing head *can* be made completely upon a 4-in. lathe costing





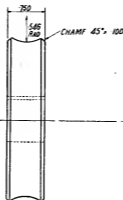
Thrust locking nuts; two off
—Nickel steel.



STEEL WORM

2 STARTS OF 4 T.P.I.	DEPTH OF TOOTH .085
LINEAR PITCH .125	WIDTH OF THREAD (BOTTOM) .038
PITCH DIA 1.171	" " (TOP) .041
BOTTOM DIA 1.080	ANGLE AT SIDE OF TOOTH 14 1/2°
THREAD HELIX 3-5°	THICKNESS OF T ON PITCH LINE .0625

Steel worm—one off.



N° OF TEETH 80	THROAT DIA 3.280
LINEAR PITCH .125	OUTSIDE DIA 3.380
PITCH DIAMETER 3.181	ANGLE TO SET
RAD. OF THROAT .546	WHEEL FOR GASHING 3 1/2°

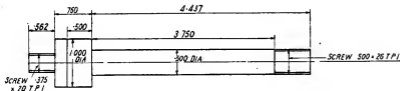
Phosphor-bronze gear—one off.

less than $\frac{1}{50}$. The bracket, therefore, is separate, and the would-be maker of similar apparatus will have the advantage discovered by the writer of being able to engage his gears with an exacting nicety.

Work should begin upon the main casting. After "fettling" to remove blemishes, the back face should be machined. Mount the casting on the lathe faceplate, gripping it by the edges with "dogs." Balance the job by bolting weights opposite the heavier side,

Before the machine is cleaned down from cast-iron carry on with the bracket. This should present no difficulties, but it really is very important to ensure that the 0.500 in. hole for the spindle is parallel with the back face, and that the 1.000 in. diameter is not plus, and not more minus than 0.0005 in. Note also that whilst the 0.250 in. holes for fastening to body may be drilled and counterbored, the dowel hole should not be drilled, nor should any attempt be made to guess the position of the tapped holes in the body. These two holes should be left for later.

The spindles and thrust nuts should now



Worm spindle; one off—Nickel steel.

then cut. A truly flat face is essential. Once this has been achieved, take the job off the faceplate and bolt down to the boring table. With a face-mill gripped in the S.C. chuck, mill the four edges square and to size. Next mark out for boring, mount again upon boring table and bore both holes at one setting. Finish both holes with reamers if possible. Finally, drill the two 0.375 in. diameter holes for bolting down, and the two 0.250 in. Whitworth tapped holes for clamping steady arm.

be made. They are all straightforward turning jobs. The only comment necessary is that the highest possible finish should be aimed at, and only extreme accuracy of fit will do. The bore of the main spindle must also be quite concentric with outside diameter, and the writer strongly recommends that the job should be finished upon a mandrel. The small keyway for locating the phosphor-bronze gear can be milled by end-mill held in the S.C. chuck.

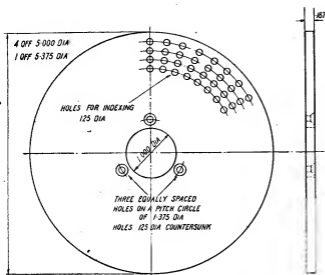
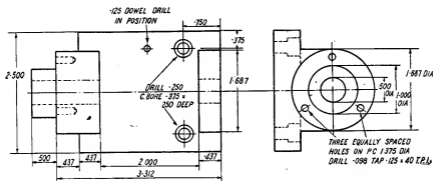
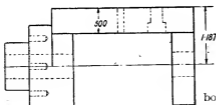


PLATE NUMBER	N° OF DIVISIONS	PITCH CIRCLE	LENGTH OF CHORD
ONE	24	3 125	406
	25	3 500	439
	28	3 875	434
	30	4 250	444
	34	4 625	425
TWO	37	3 125	253
	38	3 500	287
	39	3 875	310
	41	4 250	313
	42	4 625	344
THREE	43	3 500	252
	46	3 875	263
	47	4 250	280
	49	4 625	296
	51	3 500	213
FOUR	53	3 875	238
	54	4 250	246
	57	4 625	254
	58	3 875	209
	59	4 250	225
FIVE	62	4 625	231
	66	5 000	235

Division plates.



Bracket; one off—Cast-iron.



The phosphor-bronze gear may next be turned to dimensions given in the detailed drawings. When turning is complete and the keyway filed (or slotted) the wheel should be put on one side.

Now turn the blank for the worm, and when this is done make a blank of similar length and diameter in tool steel. Mount

both upon an arbor with the tool steel nearest the headstock of the lathe. This tool steel blank will afterwards become the hob for cutting the phosphor-bronze gear. Now cut the first thread. First use a tool as for a square thread and go to full depth. Particular care must be taken when grinding the tool to give it clearances at the sides which will enable it to clear the thread at the bottom. (The helix angle is $3\frac{1}{2}$ degrees.)

(To be continued)

*Small Capstan Lathe Tools

Examples of Tooling taken from actual practice

By "NED"

SEVERAL readers have asked for advice on tooling up capstan lathes for producing specified components, and while it has been possible in a few cases to answer their individual queries directly, it has been thought advisable to conclude this series of articles by illustrating the procedure which has been actually adopted in dealing with a number of varied components produced on a lathe fitted with a capstan attachment. In most cases, only a comparatively small number of these components have had to be produced in a single batch, and the construction of elaborate tools or fixtures has not been economically practicable. This state of affairs is, one conjectures, more or less typical of the work likely to be encountered by readers. No claim is made that the most efficient method of tooling possible has been adopted for any component, but in view of the limited tool equipment available and the necessity of arranging the tooling to be set up and re-adapted with minimum loss of time, it is believed that quite a reasonable rate of production has been attained by the methods described.

These examples have been selected with the co-operation of Mr. A. L. Steels, and represent work-pieces which he has produced in his own workshop; the ultimate purpose of the pieces does not concern us greatly, but it may be mentioned that they include components of electrical apparatus, and also

mechanical fittings, all of which are destined, for some small but nevertheless essential duty in modern engines of war.

Available Equipment

Capstan Head :

- 2 Small knee tools for parallel turning.
- 1 Vee steady tool.
- 1 Knee tool with two cutters (one adjustable).
- 1 Beveling or chamfering tool.
- 1 Double knurling tool.
- 1 Slip die-holder.
- 3 Holders for drills, etc., with adaptor bushes.
- 1 Work stop.

Cross Slide :

- Two tool posts (front and back) for forming and parting tools, respectively.

A detailed description of the actual cutters used is not considered necessary, as they conform to the types which have been fully discussed in these articles; but one or two instances of operations in which special form tools have been used will be dealt with as they arise.

Thumb Screw (Fig. 33)

This component is made from $\frac{1}{8}$ -in. round brass, and may be regarded as a very common job for a small capstan lathe. Such screws are extensively used in electrical apparatus, for terminals and panel fixtures, and were formerly even more common in camera work of the "brass, glass and mahogany" variety.

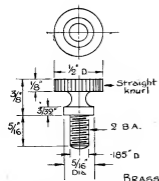


Fig. 33. Thumb screw.

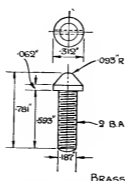


Fig. 34. Dome-head screw.

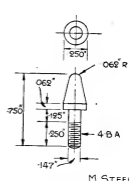


Fig. 35. Tapered head screw.

*Continued from page 228, "M.E." September 3, 1942.

Procedure

The nature and size of the work allows of making it from bar, which can be passed through the hollow mandrel and held either by the 3-jaw or collet chuck. It will be noted that no necessity arises to machine the outside diameter of the stock, so long as it is fairly uniform in diameter and reasonably true in chuck.

- (1) Set length of work by advancing work stop, and tighten chuck.
- (2) Turn down with knee tool to 5/16 in. diameter for a length of 9/16 in.
- (3) Reduce by means of vee steady tool to 0.185 in. diameter for a length of 5/16 in.
- (4) Screw 2 B.A. As the specification does not call for taking any special measures for screwing right up close to the shoulder, or for undercutting the thread, it is sufficient to cut the thread up as far as possible with one pass of the die.
- (5) Knurl the head by means of straight knurling wheels set parallel to work axis.
- (6) Form groove under head by means of a round-ended tool 5/32 in. wide, set in front tool post of cross slide, and limited to depth by cross slide end stop.
- (7) Part off with tool held in rear tool post, ground to cut head off squarely, and form end of new piece at the same time.

The sequence of tools adopted for this piece allows of removing most of the burrs formed in machining, but in case any should be left, they may be removed before completely parting off by means of a smooth hand file.

Dome-head Screw (Fig. 34)

This is made from 5/16-in. diameter brass, and again requires no machining on the outside diameter.

- (1) Advance work stop to set length; tighten chuck.
- (2) Chamfer end with bevel tool.
- (3) Reduce to 0.185 in. diameter with vee steady tool for a length of 0.593 in.
- (4) Screw 2 B.A.
- (5) Remove burr on end of thread with cutter set to 45 deg. in knee tool holder.
- (6) Steady end of work, by means of steady-bush held in drill holder, for combined parting and forming operation.
- (7) Form and part off with single tool ground to shape of head, held in front tool post of cross slide.

Tapered Head Screw (Fig. 35)

The material used in this case is $\frac{1}{4}$ in. diameter mild steel. Although somewhat similar in shape to the preceding piece, it is not practicable to form the head by the same method, owing to the length of taper, entailing the use of an excessively broad tool; the accuracy and finish called for could not be obtained in this way. Room could not be spared for the manipulation of the swivelling top slide, and the quantity required did not justify making up a special cross-traversing tool for the turret head or cross slide. It was therefore considered advisable to make this part in two operations.

First Operation :

- (1) Set to length with work stop; tighten chuck.
- (2) Reduce to 0.147 in. diameter with vee steady tool, for a length of $\frac{3}{8}$ in.
- (3) Screw 4 B.A. for a length of $\frac{1}{4}$ in.
- (4) Chamfer end of work with bevel tool.
- (5) Part off with plain parting tool in front or rear cross slide tool post.

Second Operation (carried out in screwed collet) :

- (1) Turn taper with tool in swivelling top slide tool post.
- (2) Radius top of head; for small quantities this may be done with a hand tool or fine file. Larger quantities justify setting up a form tool in rear tool post.

Long Pivot Pin (Fig. 36)

The particular feature of both this and the next component is that very close limits of accuracy are necessary on the shank diameter. It is necessary to turn the outside edge of the head, not only to ensure concentric accuracy, but also because no stock of the required diameter was readily available.

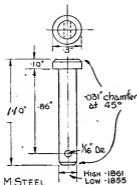
- (1) Set to length with work stop and tighten chuck.
- (2) Chamfer end with cutter set to 45 deg. in knee tool holder.
- (3) Reduce to 0.1855 in. diameter with vee steady tool, to a length of 0.1 in.
- (4) Turn head to 0.3 in. diameter with knee tool, for a length of $\frac{1}{8}$ in.
- (5) Chamfer top of head with form tool ground to 45 deg. in front tool post of cross slide.
- (6) Part off with plain parting tool in rear tool post.

Short Pivot Pin (Fig. 37)

The procedure is similar to that of the former component, except for the differences in the dimensions, and that the end is radiused, and the head is not chamfered.

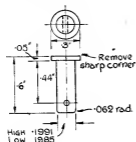
Contact Stud (Fig. 38)

This component is produced in 3/16 in. diameter nickel-silver, which is liable to be somewhat tricky in machining, and to call for special care in grinding and setting

**Fig. 36. Long pivot pin.**

tools. It is intended to be pressed into a hole in a panel of plastic material, hence the knurling under the head to provide an efficient friction grip in the hole; presumably the small end is connected, by soldering to a wire or tag at the back of the panel.

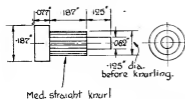
- (1) Set to length with work stop and tighten chuck.



M. STEEL

Fig. 37. Short pivot pin.

- (2) Reduce to 0.125 in. diameter with steady tool for a length of 0.312 in.
- (3) Reduce to 0.062 in. diameter with knee tool for a length of 0.125 in.
- (4) Knurl with straight knurls set parallel with work axis.

**Fig. 38. Contact stud.**

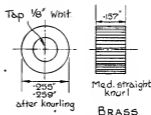
- (5) Part off with plain parting tool in front or rear cross slide tool post.

Domed-head Contact Stud (Fig. 39)

The procedure in this case is similar to the preceding component, allowing for differences in dimensions. To form the domed head, a combined forming and parting tool was employed; this was effective in producing the correct shape except that a small pip was left in the centre, which was removed in a second operation and the head polished.

Knurled Bush (Fig. 40)

This component was also intended for insertion in a plastic composition panel, in this case being put into a counterbored hole from the back to form a secure anchorage for a 1/2-in. screw. It is made in 1/4 in. diameter brass, and as will be seen, the knurling

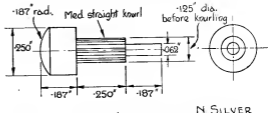
**Fig. 40. Knurled bush.**

operation increases the maximum outside diameter of the stock from five to nine thousandths of an inch.

- (1) Set to length with work stop and tighten chuck.
- (2) Centre drill end face.
- (3) Drill with 1/8-in. tapping drill to a depth of 3/16 in.
- (4) Tap 1/8 in. Whitworth.
- (5) Knurl with straight knurls set parallel with work axis.
- (6) Part off with plain parting tool set in either front or rear cross slide tool post.

Spring Retaining Screw (Fig. 41)

The purpose of this component was to centre and form a stop for a small compression spring. For some reason unknown to the writer it was specified as being made in phosphor-bronze, another material which

**Fig. 39. Domed-head contact screw.**

is liable to involve a certain amount of trouble if all tools are not kept properly ground and set; particularly drills, taps, dies, and inside cutters.

- (1) Set length with work stop and tighten chuck.
- (2) Using knee tool with two cutters, one of these is set to reduce work to 0.381 in. diameter for a length of 5/16 in., and the other to chamfer the end.

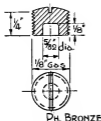


Fig. 41. Spring retaining screw.

- (3) Screw $\frac{1}{8}$ in. gas for a length of 5/16 in.
- (4) Centre drill end face.
- (5) Drill 5/32 in. diameter for a depth of $\frac{1}{8}$ in.
- (6) Bottom hole with flat-ended cutter or D-bit, with rounded corners.
- (7) Form and part off with combined tool, held in either front or rear cross slide tool post.

Spring Anchor Screw (Fig. 42)

This is made in round brass 3/16 in. diameter, and is intended for the purpose of anchoring a small tension spring.

- (1) Set length with work stop and tighten chuck.
- (2) Reduce to 0.156 in. diameter for a length of 7/16 in. with knee tool.

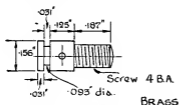


Fig. 42. Spring anchor screw.

- (3) Reduce to 0.147 in. diameter for a length of 3/16 in. with second knee tool.
- (4) Chamfer end of work with bevel tool.
- (5) Screw 4 B.A. for a length of 3/16 in.
- (6) Groove head with parting tool held in front tool post.
- (7) Part off with plain parting tool in rear tool post.

In actual fact, operations 6 and 7 were carried out with a single parting tool located in the front tool post. In order to obtain the correct endwise setting, a stop was fitted to limit the saddle traverse. For parting, the saddle was fed up against the stop; for grooving, a slip of 1/16-in. material was interposed between stop and saddle. This method is perfectly satisfactory when the work is carried out by a skilled, or at any rate careful, operator; but the procedure recommended above is more "fool-proof," and would quite definitely be preferred in general production practice.

Contact Plunger (Fig. 43)

It is quite probable that this is a counterpart of the spring retaining screw above

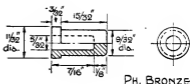


Fig. 43. Contact plunger.

described, being of the same material and drilled in a similar manner. Quite possibly it is intended to serve a purpose similar to that of the spring contacts in an ordinary bayonet-type lamp holder. The size of material employed was $\frac{1}{8}$ in. diameter, much larger than was really necessary, but presumably this was a question of available supplies.

First Operation :

- (1) Set length by work stop and tighten chuck.
- (2) Using knee tool with two cutters, one is used for roughing down to about $\frac{3}{8}$ in. diameter, and the other for finishing to 11/32 in. diameter for a length of $\frac{3}{8}$ in.
- (3) Radius end with bevel tool.
- (4) Reduce to 9/32 in. diameter with steady tool to a length of 15/32 in.
- (5) Part off with plain parting tool in front or rear tool post.

Second Operation (in collet chuck) :

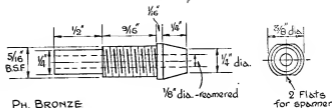
- (1) Centre drill end face.
- (2) Drill 5/32 in. diameter for a depth of 7/16 in.
- (3) Bottom hole with flat cutter or D-bit with rounded corners.

Screwed Bush (Fig. 44)

This is also made from $\frac{1}{8}$ in. diameter phosphor-bronze, and again calls for two operations.

First Operation:

- (1) Set length with work stop and tighten chuck.
- (2) Using knee tool with two cutters, one is used to reduce outside to $\frac{3}{8}$ in. diameter for a length of $1\frac{1}{2}$ in., and the other to reduce screwed portion to $5/16$ in. diameter for a length of $1\frac{1}{16}$ in.
- (3) Reduce end to $\frac{1}{4}$ in. diameter with single knee tool for a length of $\frac{1}{2}$ in.
- (4) Screw $5/16$ in. B.S.F. as close up to head as possible.
- (5) Part off with plain parting tool in front or rear tool post.

*Second Operation (in screwed collet):*

- (1) Turn taper with tool held in swivelling top slide.
- (2) Centre drill end face.
- (3) Drill $\frac{1}{4}$ in. reamer size right through.
- (4) Reamer $\frac{1}{4}$ in. diameter.

In the case of this component it was found convenient to file the flats on the head of the bush while holding the work in the screwed collet, indexing it in the two diametrically-opposed positions by turning the mandrel. Other parts call for more or less comparable operations, such as cross slotting, which was done by means of a circular saw in the lathe, a simple cross slide fixture being used to hold and locate the work; or cross drilling, which was done in a small sensitive drilling machine, with the work held in a simple drilling jig.

It will be noted that in all these components, knee tools were used for all roughing operations, or those which did not call for close limits of accuracy of finished diameters, such as on surfaces to be knurled or screwed. The vee steady tool was used for all close-limit turning; a roller steady, if available, might have been even better for the mild-steel and phosphor-bronze components. So far as was practicable, the sequence of operations was planned so that burrs raised by one tool were removed by one of the subsequent tools. The term "chamfering" may be taken to include the shaping, whether rounded or angular, of screw ends.

It may be remarked that in the execution of this work, the specified limits were attained and maintained, and the percentage of parts scrapped through machining errors was very small indeed; thereby demonstrating the practicability of the methods, and the utility of the equipment employed.

These examples will, it is hoped, help many readers to solve their own production problems, but the writer will always be prepared to advise on any special problems which may arise, including tooling for parts of special complexity, or difficulties which may be encountered in working to close limits. Although this series of articles is now concluded, there is little doubt that the

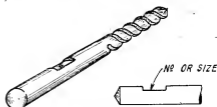
Fig. 44. Screwed bush.

Editor would allow the subject to be re-opened to deal with such matters if they are likely to be of general interest to readers.

There is plenty of evidence that the series has been of practical assistance to many readers who are using their home workshops for war production, not to mention quite a few who are engaged on tool setting and planning in "real live" factories. Thanks are due to those readers who have expressed appreciation of the efforts of the writer, and also to those who have offered kindly and constructive criticism. Even if the reader has not the slightest intention of undertaking quantity production work, a study of the methods involved, and the tools and equipment used, cannot do any harm, but on the other hand is almost bound to give him many new ideas for tackling his individual problems, and to broaden his outlook on the vast issues of modern engineering.

Numbering Drills Durably

The annoying trouble of drill numbers and sizes being erased from the drill shafts by revolving within the chuck can be



mitigated by recessing the numbers as shown in sketch. The flat should be ground out, and the numbers stamped.—F. C.

Setting Out a Two-Throw Crankshaft

By G. E. SAVAGE

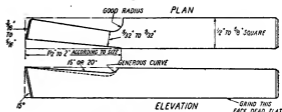
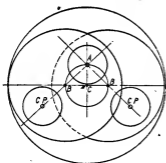
THE following suggestion is proffered as an aid to those who prefer their crankshafts whole. One of the troubles of any eccentric turning is the amount of "wobble" arising during the process. The following setting out reduces the "wobble" to a comfortable amount.

First:—to set out the centres—

- (i) As each face of the blank to be used is trued in the chuck a fine centre, C, is marked in, using a short piece of No. 55 drill (or near) inserted in a piece of brass rod as centre drill. From this centre a circle is drawn, either using the cross-slide index to measure the radius and marking each end of the bar in turn (by means of a fine-pointed tool) without moving the cross slide (this is the more accurate), or using dividers and rule.

To find the radius of the setting-out circle refer to sketch:—

$$CA = \text{square root of } \left(\frac{\frac{1}{2} \text{ crank throw}^2}{2} \right)$$



A strong parting tool.

E.G. Crank throw = $\frac{1}{2}$ in.—A to CP
 Half of $\frac{1}{2}$ in. = $\frac{1}{4}$ in. and $(\frac{1}{4} \text{ in.})^2 = 0.14$
 Half of 0.14 = 0.07 in. and square root of 0.07 in. = 0.264 in.

or, for those with dividers, $\frac{1}{4} \text{ in.} \times 1/64$. This is the radius to be used for the first circle.

- (ii) Now remove the blank from the chuck, get out your surface plate and vee-blocks. With the aid of a scribing-block and a square draw line B B right across both ends at one and the same setting and line A C at right-angles to it just across the circle already drawn. From these lines points A, B, BB will be found, check with dividers to see if AB = throw required—it should be accurate if care has been taken with the calcula-

tions. Draw a line through AB each way and on each end to give location of CP. The dividers are now set to distance BA, using B as centre, B to CP = B to A. Carefully make correct centres at A, B, B, CP, CP. If eccentrics are required these can be set out by putting line A—CP horizontal to the scribing block (each in turn) and then setting out the appropriate advance line as may be required. A circle with centre A will include all the eccentric centres.

If it is proposed to use eccentric centres it will be necessary to set out the circles beforehand in order to arrive at an appropriate size of bar.

The following sizes will act as a guide:—

- 4 $\frac{1}{2}$ in. long \times 2 in. diameter for 1 $\frac{1}{2}$ -in. stroke and 3 $\frac{1}{2}$ -in. gauge.
- 4 $\frac{1}{2}$ in. long \times 2 $\frac{1}{2}$ in. or 2 $\frac{1}{2}$ in. diameter for 1 $\frac{1}{2}$ -in. stroke and 3 $\frac{1}{2}$ -in. gauge.
- 3 $\frac{1}{2}$ in. long \times 1 $\frac{1}{2}$ in. or 1 $\frac{1}{2}$ in. diameter for 2 $\frac{1}{2}$ -in. gauge.
- 2 $\frac{1}{2}$ in. long \times 1 $\frac{1}{2}$ in. diameter for 1 $\frac{1}{2}$ -in. gauge.

- 2 $\frac{1}{2}$ in. long \times 1 in. diameter for 1 $\frac{1}{2}$ -in. gauge, single crank.

The order of the turning operations will, of course, depend on personal preference, but it is suggested that the following order will work out comfortably:—

- (i) Centres B: rough turn as far as second web on each side to outside diameter of web plus an allowance for finishing. This will leave a piece for either eccentrics, or for a short piece of crankshaft; if the latter, this can next be reduced to a $\frac{1}{4}$ in. over size, using centre A (A throw plate will, of course, be left at each end).
- (ii) Centres CP: proceed to rough turn the crank pins, using slow speed and with all slack taken out of your slides.

If possible, clamp your main slide tight to the bed after setting and work with cross slide and top slide only. It is worth while buying or making a special tool for this purpose. I use a piece of high-speed steel carefully shaped with 5 degrees side rake, 15 to 20 degrees top rake (short), and 15 degrees front rake. Also, the corners are carefully rounded with an oilstone.

This tool, carefully used, will bring shavings off in fine style. (See sketch.)

The tool has many uses: Made with front corners carefully rubbed round, it will cut out crankshafts.

Made a little wider, say, $\frac{3}{8}$ in., and the front cutting edge rounded a trifle, it will polish the shaft at slow speed, and fairly fast feed.

There is little to be afraid of—the order of the day being—Make haste slowly.

It is quite a pleasant evening's amusement

Letters

Suggestions for Miniature Indicators

DEAR SIR,—I feel that I must answer the implied challenge issued by "L.B.S.C." in his article and heading "Science at a Discount." It is not the use of science which brings it into disrepute, but its misuse and abuse.

With regard to the small scale indicator, it is optimism of a very high order to expect an indicator of normal "full-size" design, suitably scaled down, to function satisfactorily on a small scale cylinder. One doesn't normally expect to register the barometric pressure with a 250 lb. pressure gauge, or to crack monkey-nuts under a forge hammer. It is neither the right tool nor a scientific method.

It is hoped that someone may be able to investigate the practicability of the following scheme, despite the limitations in time and material imposed by war conditions. Only the veriest outline of the scheme is presented, but here it is:—

Use a mercury-in-glass manometer—see sketch—with a sealed air space above the mercury; the air space will probably need to be of small volume, as this is the equivalent of the spring of a normal indicator; the air in this space is balanced to atmospheric pressure at the commencement of operations by the stop-cock—which stop-cock must be really air-tight when closed. The movements of the mercury meniscus to be recorded on (baby) ciné film, arranging that crosshead position is simultaneously recorded. This should present a system in which friction and volumetric errors are at a minimum. By plotting the pressure record against crosshead movement, a

turning one of these for gauge "1" (or even for gauge "O"!!!!)

When all the various parts have received their due share of attention from the roughing tool, have a good sharpen up—making, if you like, two little side-facing tools (one R.H., one L.H.) for cleaning the sides of the webs. Remember always to round the corners of your tool.

The finishing process should be carefully done. It is worth while making gauges for all parts duplicated.

NOTES.—For those who find calculations difficult:—

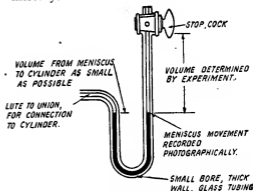
Gauge 5 in.— $2\frac{1}{2}$ in. stroke. Setting-out circle radius = 0.4 in.

Gauge $2\frac{1}{2}$ in.— $1\frac{1}{4}$ in. stroke. Setting-out circle radius = 0.2 in.

Gauge $1\frac{1}{2}$ in.—20 mm. stroke. Setting-out circle radius = $9/64$ in.

Gauge "O"— $\frac{3}{8}$ in. or 16 mm. stroke. Setting-out circle radius = $7/64$ in.

reasonable indicator diagram of conventional shape should be obtained. Actual pressures could be obtained by utilising Boyle's Law—applying it to the air-space above the mercury.



May I conclude by expressing an appreciation of the articles and efforts of "L.B.S.C.", reiterating, however, that it is not science, but pseudo-science which is at a discount.

Yours faithfully,
J. L. MAYHOOK.

Liverpool.

A Clamp to Stop Bruising Fingers

DEAR SIR,—I have just read the hint given under the above heading in your issue of September 3rd. Surely the correct way to prevent bruised fingers when filing is to hold the file in a proper manner. Damaged fingers through filing is a very rare accident among tradesmen, and to hold a flat file outside of the clamp shown in the sketch is not good practice, and most certainly does not produce accurate work.

Yours faithfully,
A. HAHN.

Manchester.

A Point in English

DEAR SIR,—Referring to the piquant correspondence on page 191 of THE MODEL ENGINEER of 20th August, and the Editorial comments thereon:—

The French name for a "spiral staircase" is "Escalier en Helice," and this is no doubt scientifically correct.

The dispute appears to arise from the fact that a "spiral" may be (a) winding round and receding from the centre or nodal point (like a watch spring), or (b), at the same time rising or advancing forward.

In the first case it is a "volute spiral," in the second case it is a "helical" spiral.

Yours faithfully,

Cockermouth. T. E. C. RODHAM.

Re-evaporation in a Steam Cylinder

DEAR SIR,—In the August 13th issue Mr. P. W. Wilson raises the question of re-evaporation due to compression in a steam engine cylinder at the end of the exhaust stroke. Actually, in a cylinder supplied with steam not superheated and working expansively the re-evaporation occurs towards the end of the power stroke. Sir Alfred Ewing, in his work on the steam engine, states: "When steam is admitted at the beginning of the stroke, the cylinder and piston having been chilled by exposure to low pressure steam during the exhaust of the previous stroke, a portion is condensed

and, as the piston advances and more chilled surface is exposed, the condensation goes on after 'cut off.' During expansion the cylinder contains a film of water spread over the exposed surface, in addition to saturated (i.e. non-superheated) steam. There is a further condensation due to (heat converted into) work which the steam is doing during expansion. As the pressure falls the layer of water which has been deposited begins to be re-evaporated as soon as the temperature of the expanding steam falls below that of the liquid layer. From this point the mixture of steam and water becomes more and more dried . . . and the process of re-evaporation continues during the return (exhaust) stroke."

I have slightly condensed Professor Ewing's statement, but he goes on to point out that "in extreme cases when the initial condensation has been very great the cylinder walls may fail to become dry during exhaust." It will be obvious that re-evaporation at the end of the power stroke is detrimental in that it increases the back pressure. From the foregoing considerations the advantage of drying steam by superheating, and thus preventing or reducing initial condensation at the commencement of the stroke and re-evaporation at the end thereof, becomes very clear.

Yours faithfully,

Earsdon. H. W. DAVIS, M.Inst.C.E.

Clubs

The Society of Model and Experimental Engineers

The Workshop at 20, Nassau Street, London, W.1, is open on Tuesdays and Thursdays at 7 p.m., and on Saturdays at 5 p.m., and meetings will be resumed shortly.

Secretary, H. V. STEELE, 14, Ross Road, London, S.E.25.

The City of Bradford Model Engineers' Society

At the meeting on Sunday, September 20th, we shall draw the names of a few members out of a hat and those who will be required to give a few minutes' talk on any subject of interest to the other members.

The above meeting will be held at Tong Unionist Club at 10.30 a.m.

We still offer a hearty invitation to all members of H.M. Forces.

Hon. Secretary and Treasurer, G. BOWER, 33, Moore Avenue, Wibsey, Bradford.

The Junior Institution of Engineers

Friday, 18th September, 1942, at 39, Victoria Street, S.W.1, at 6 p.m., Informal Meeting. Paper "Rail Cars." by Norman L. Ablett, B.Sc., Wh.Ex. (Member).

Leeds Model Railway and Engineering Society

On Saturday, September 19th, Mr. W. D. Hollings will give a talk on Model Boiler Making; this meeting will commence at 2.45 p.m.

Meeting place, F. Cook, Kidacre Street, Leeds.

Hon. Sec., H. E. STAINTHORPE, 151, Ring Road, Farnley, Leeds.

The West Midlands Model Engineering Society (Wolverhampton Branch)

It was decided at the last meeting of the above Society to start again in earnest on Wednesday, September 23rd, at our headquarters, the "Red Lion" Hotel, Snow Hill.

Hon. Sec., F. J. WEDGE, 13, Holly Grove, Penn Fields, Wolverhampton.

NOTICES.

The Editor invites correspondence and original contributions on all small power engineering and electrical subjects. Matter intended for publication should be clearly written, and should invariably bear the sender's name and address.

Readers desiring to see the Editor personally can only do so by making an appointment in advance.

All correspondence relating to sales of the paper and books to be addressed to Percival Marshall and Co. Ltd., Cordwallis Works, Maidenhead, Berks.

All correspondence relating to advertisements to be addressed to THE ADVERTISEMENT MANAGER, "The Model Engineer," Cordwallis Works, Maidenhead, Berks.